Marrett Road Intersection

Phase II

REPORT

Prepared for

Town of Lexington, Massachusetts

Prepared by

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CREATIVE SOLUTIONS
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Introduction

For a number of years, the Town of Lexington has been considering alternatives for improvements at the intersection of Marrett Road/Spring Street/Bridge Street (see **Figure 1).** Traffic problems at the intersection are tied to vehicular volumes generated by employment centers approximately one mile south of the intersection. Lexington's zoning bylaw requires developers to mitigate unacceptable level of service conditions (LOS F) created by their projects, and this intersection has been reviewed for mitigation on several occasions.

In 2005, the Town engaged Howard/Stein-Hudson Associates (HSH) to conduct a two-phase study that began with a systematic, comprehensive public process with broad outreach to interested and affected parties. In July 2005, HSH completed Phase I of the study, the results of which are documented in the report entitled *Marrett Road/Spring Street/Bridge Street Intersection Study – Phase 1*. The Phase I study led to the conclusion that deficiencies at the intersection included more than level of service problems and that conditions for pedestrians, cyclists, and abutters need attention as well. Phase II of the study has focused on developing conceptual sketches of potential improvements.

Study Goals

The goals of the overall study were to look at the intersection comprehensively to understand all issues; to explore what improvements residents, drivers, and business people want; and to develop alternatives that address not only peak-hour problems but also community desires. These goals were broader and more representative than previous goals for improving the intersection. The study will then serve as a basis for the implementation of a series of safety and operational improvements that have been developed with public input and support.

Study Process

The methodology for the study maximized input early in the process to help identify problems and issues. HSH and the Town Planning Department interviewed key stakeholders, met with an advisory group familiar with the intersection, and listened to a wide range of concerns and desires for the area. Phase I culminated in a widely attended public meeting at the Cary Library in June 2005, at which close to 100 participants worked to identify potential strategies to address their issues and concerns. The Phase I report reflected the input from the public and recommended additional study in Phase II of geometric improvements and a left-turn lane on Marrett Road westbound and further study of a modern roundabout and traffic signal at the intersection. In addition, pedestrian improvements, a relocated westbound bus stop, and changes to Bridge Street would be examined in Phase II as stand-alone improvements or as part of a larger improvement.

Figure 1. Project Location

Existing Conditions Analysis

Phase II of the study began with a comprehensive data-collection program consisting of manual turning movement counts, daily automatic traffic recorder counts, and field observation. To establish a baseline traffic condition, HSH took continuous traffic counts at each approach to the intersection over a three-day period from Thursday, November 3, to Saturday, November 5, 2005. Traffic counters were installed at the following locations:

- Marrett Road (East of Spring Street);
- Marrett Road (West of Spring Street);
- Spring Street (South of Marrett Road);
- Bridge Street (South of Marrett Road); and
- Shade Street (West of Spring Street).

HSH took a continuous 24-hour count at Shade Street west of Spring Street on Friday, November 4, 2005, and a supplementary 24-hour traffic count at Spring Street south of Marrett Road in February 2006.

Bridge Street was studied to help assess the viability of closing the street or restricting turns. Shade Street was studied to help evaluate how much traffic uses the street to bypass congestion at the Marrett Road/ Spring Street intersection.

A manual turning movement count was taken at the Marrett Road/Spring Street/Bridge Street intersection from 7:00 to 9:00 a.m. and 4:00 to 6:00 p.m. on Thursday, November 3, 2005.

Daily Traffic Counts

The average daily traffic (ADT) for each of the streets is shown in **Table 1.** The traffic flow along Marrett Road is consistent over the two weekdays, with a variation of only 0.8% along Marrett Road west of the intersection and 1% east of the intersection.

Table 1. Average Daily Traffic for Approach Roadways

	Thursday	Friday	Saturday
Marrett Road West of Spring Street	13,177	13,069	9,598
Marrett Road East of Spring Street	12,363	12,496	9,598
Spring Street	7,380		
Bridge Street	284	349	234
Shade Street	1,164		

The variation of traffic flow along each of the traffic count locations is given below in **Figure 2** through **Figure 6.** The figures illustrate traffic flow variation through 24 hours on an average weekday. The x-axis represents the time of day, and the y-axis the number of vehicles passing the traffic counter location. The y-axis is constant through all the figures (from 0 to 1,600 vehicles per hour) to clearly compare the traffic flow along each of the streets.

Based on these traffic flows, the following observations can be made:

- There are two distinct peak periods for traffic using the intersection: from 7:00 to 9:00 a.m. and from 4:00 to 6:00 p.m.
- The peaking of traffic is distinctly apparent for Spring Street traffic, as shown in **Figure 4.**
- Traffic flow along Bridge Street is low throughout the day, peaking at 48 vehicles per hour (less than 1 per minute) on a Friday afternoon.
- Shade Street experiences an increase in eastbound traffic in the morning peak and in the westbound evening peak.

Figure 2. Average Daily Traffic, Marrett Road West of Spring Street

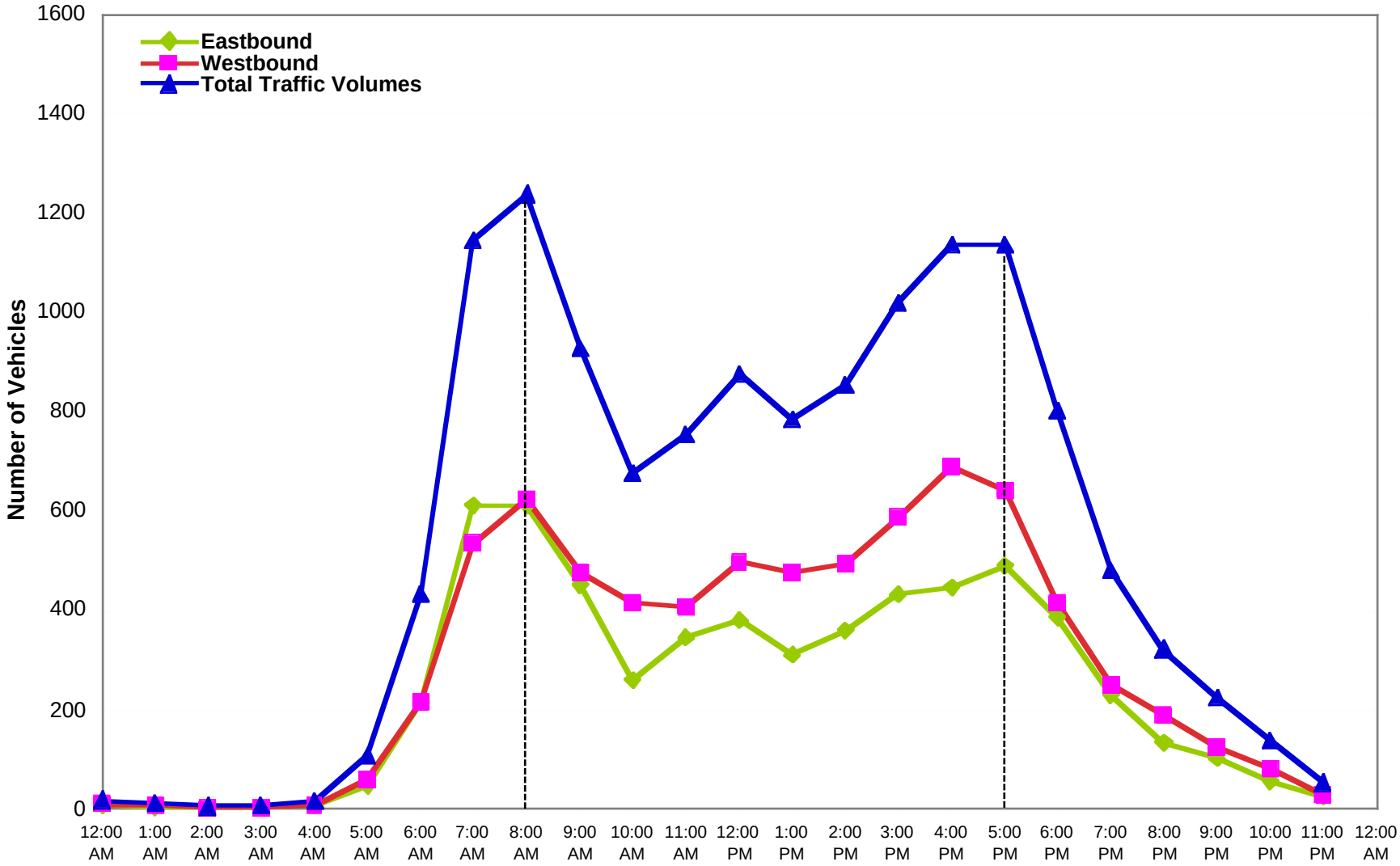


Figure 3. Average Daily Traffic, Marrett Road East of Spring Street

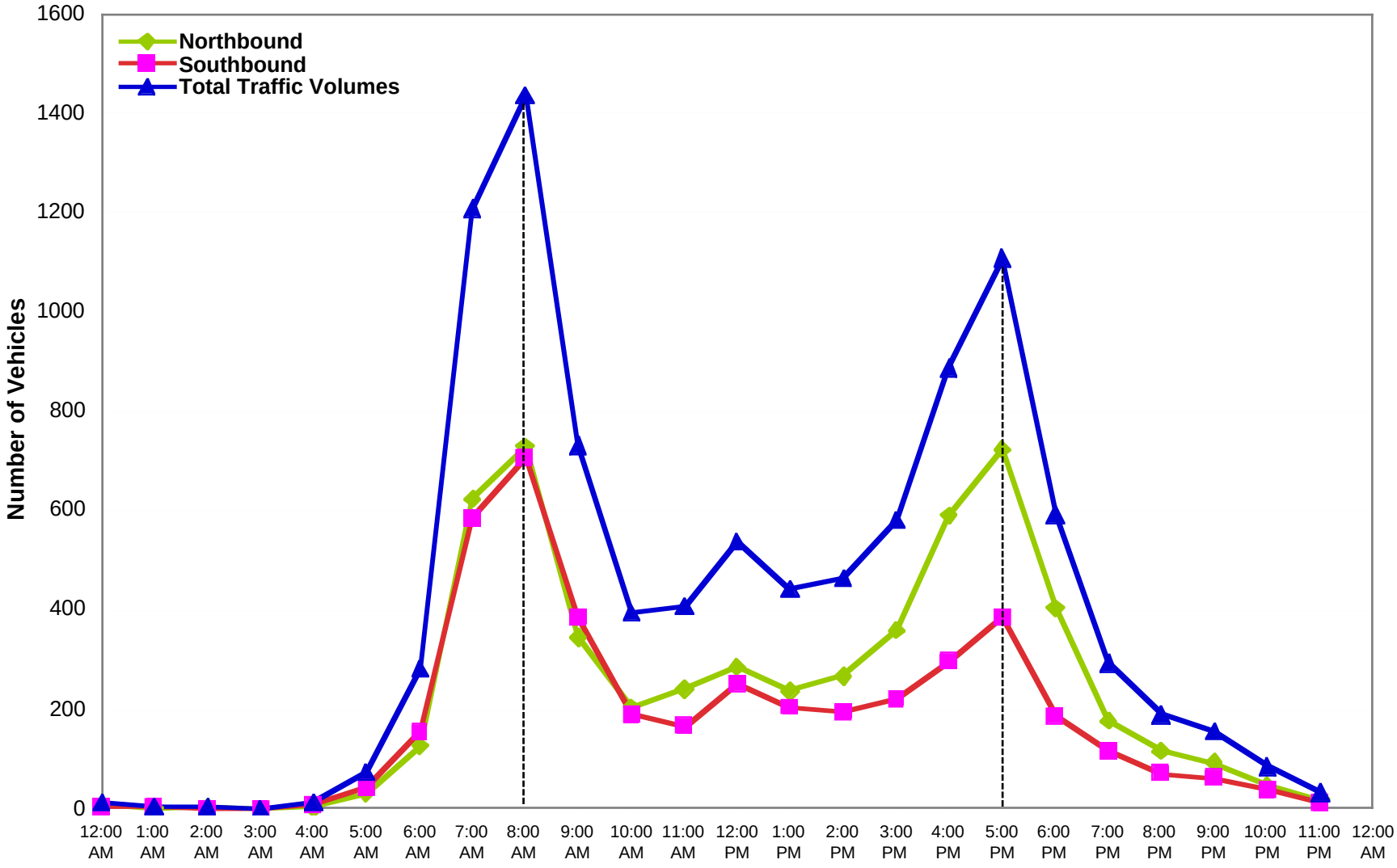


Figure 4. Average Daily Traffic, Spring Street

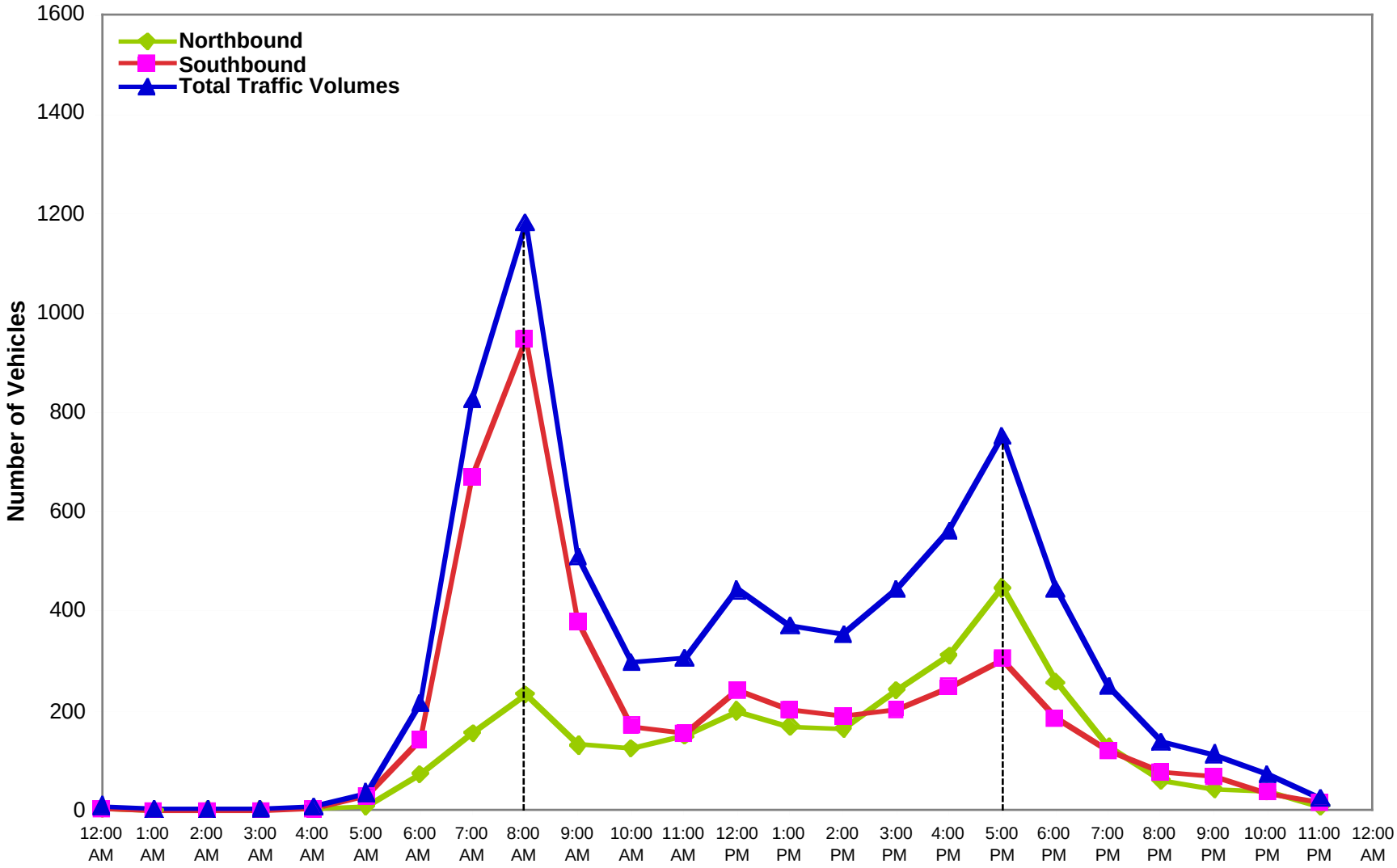


Figure 5. Average Daily Traffic, Bridge Street

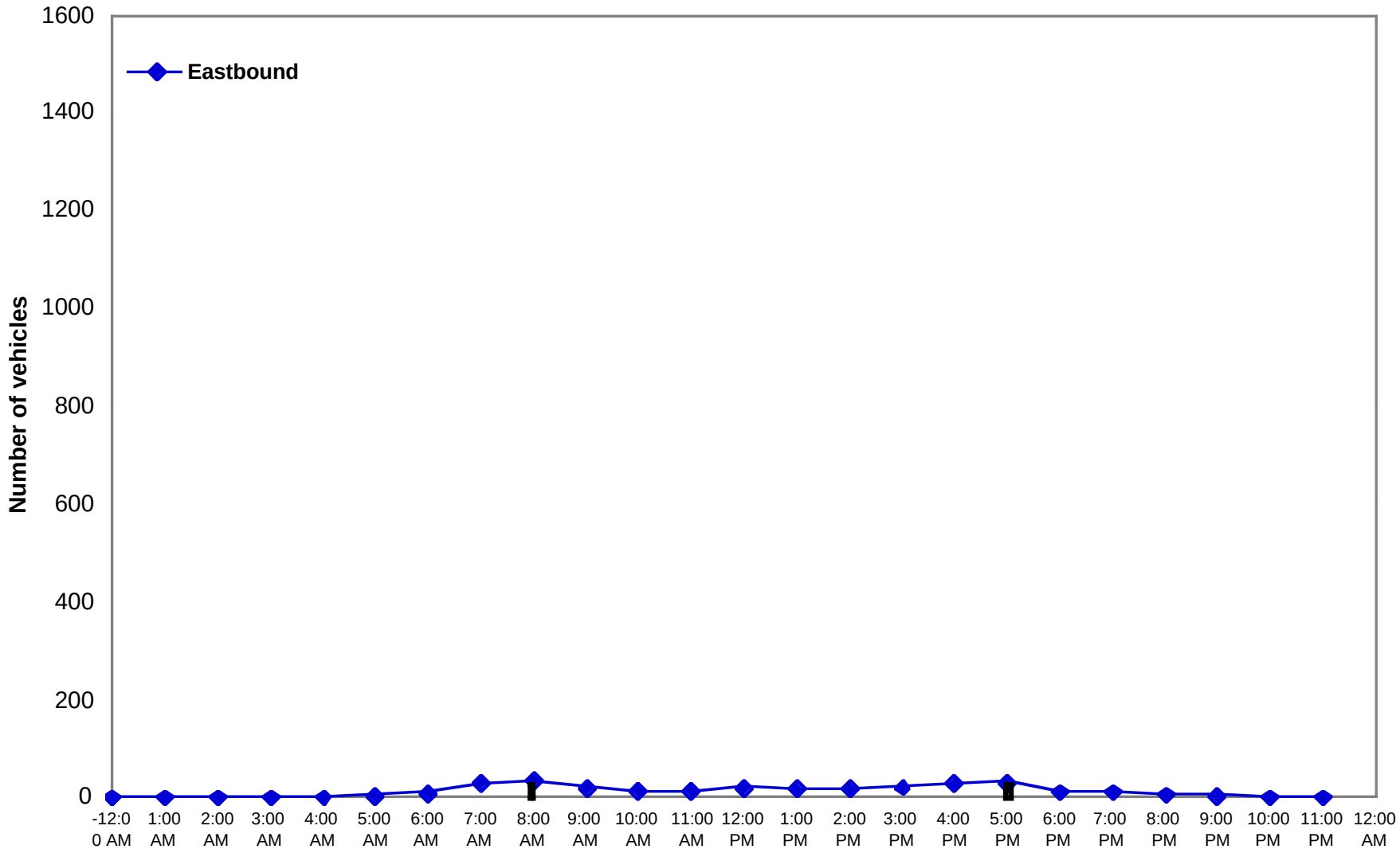
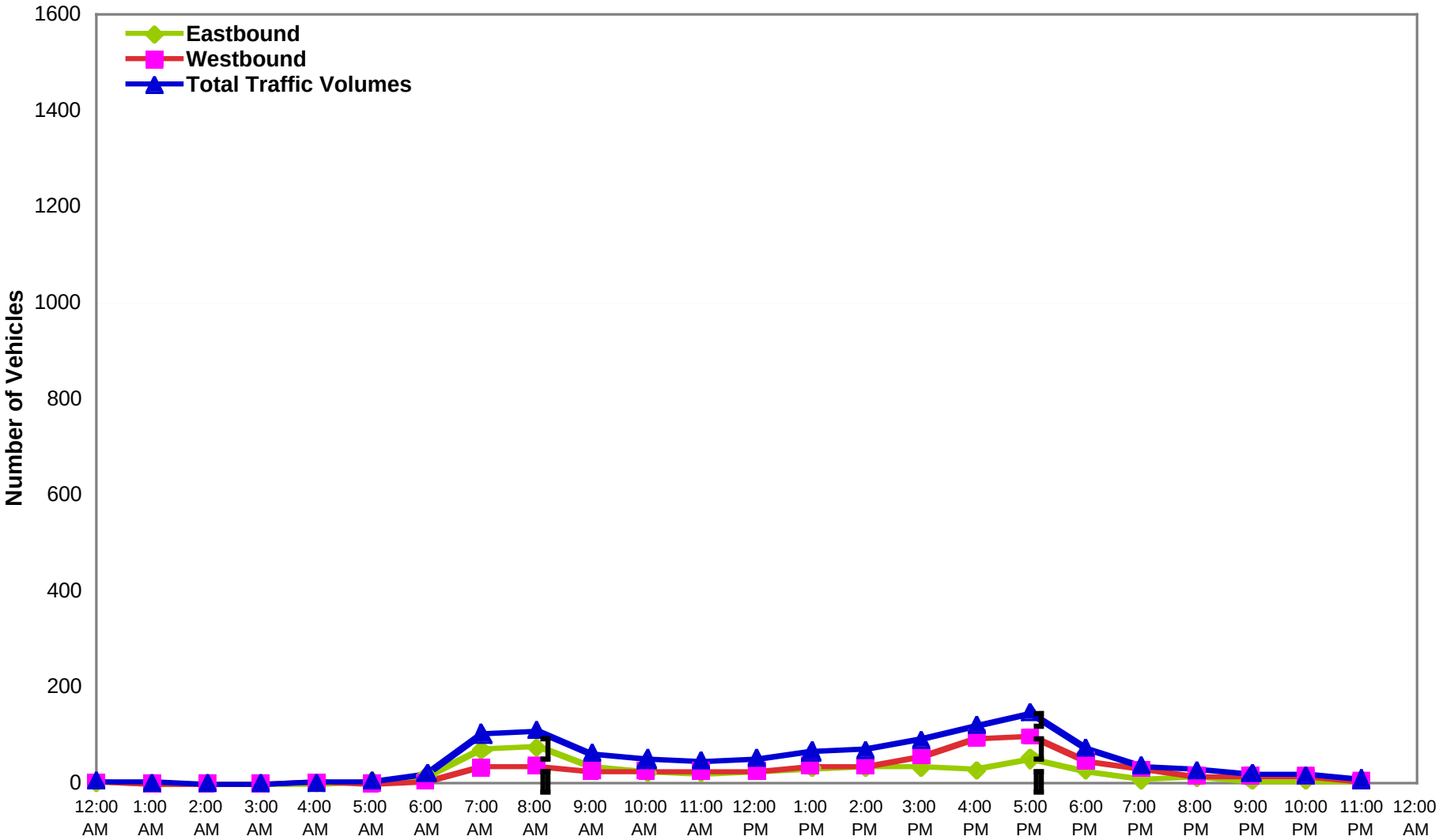


Figure 6. Average Daily Traffic, Shade Street



Peak-hour Turning Movement Counts

As expected, the continuous traffic count program confirms that traffic flow at the intersection peaks during the standard commuting hours in the morning and evening. Significant queuing along the Spring Street approach is clearly evident in the evening peak hour. This condition was noted by residents and stakeholders in the public outreach process. To augment the traffic flow data and to permit further detailed traffic operation analysis at the intersection, HSH took a manual turning movement count on Thursday, November 3, 2005. The results of the count are shown in **Figure 7.** The count has been coupled with a similar count taken four years earlier in October 2002. The comparison allow for the following observations regarding the changes in traffic flow at the intersection:

- Total traffic entering the intersection increased by 8% (from 1,834 to 1,985 vph) in the a.m. peak and by 4.5% (1,488 to 1,555 vph) in the p.m. peak.
- Traffic driving towards the employment centers along Hayden Avenue south of the intersection increased by 28% (from 755 to 968 vph) in the a.m. peak
- Northbound Spring Street traffic from the employment centers increased by 46% (from 415 to 608 vph) during the p.m. peak.

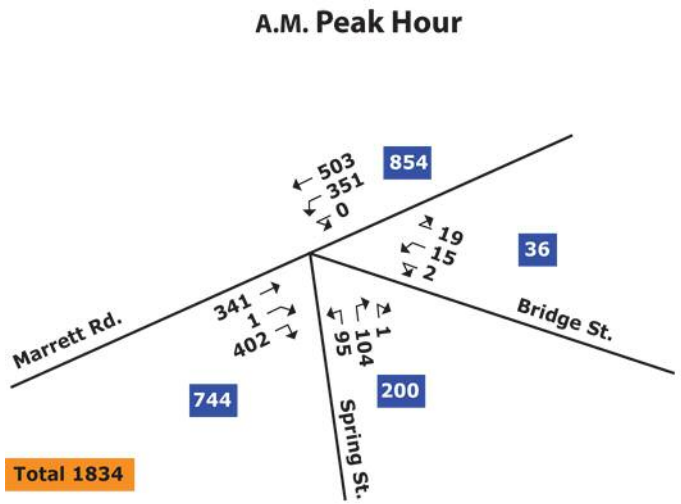
The growth in traffic volumes at the intersection is documented in **Table 2.**

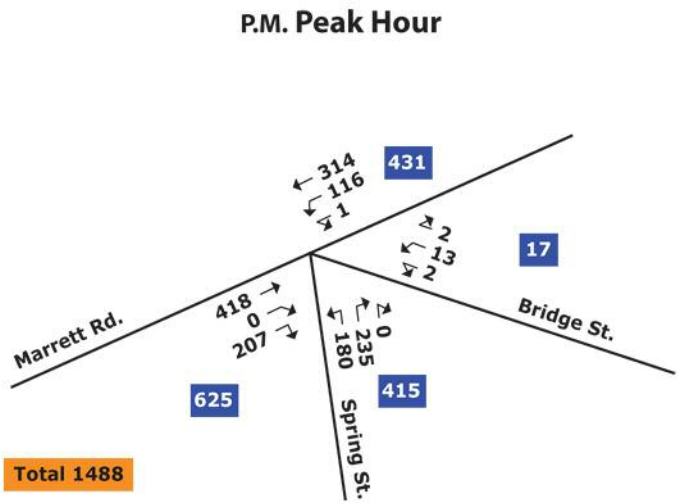
Table 2. Increase in Traffic Volumes, Marrett Road/Spring Street/ Bridge Street Intersection

	a.m. Peak Hour	p.m. Peak Hour
January 1974	1,302	1,314
October 1997	1,546	1,313
October 2002	1,834	1,488
November 2005	1,985	1,555

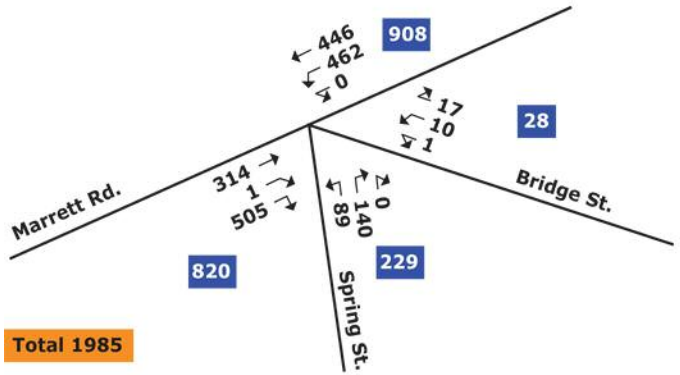
Figure 7. Peak Hour Traffic Counts

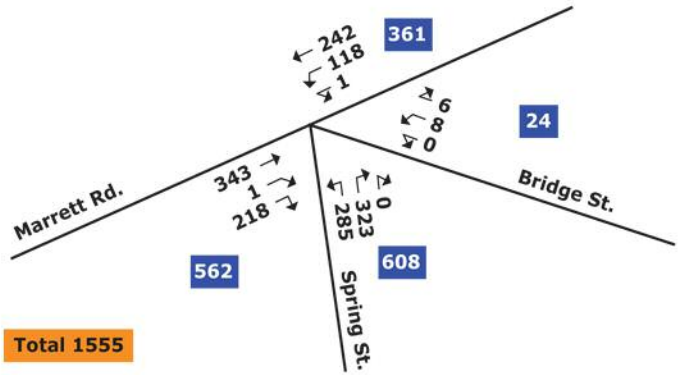
October 2002





November 2006





Speed Study

Participants throughout the Phase I public outreach process voiced concerns regarding vehicular traffic speeds along Marrett Road. HSH conducted a speed study of traffic flow along Marrett Road east of Spring Street on November 4, 2005. The posted speed limit is 30 mph for both eastbound and westbound traffic along Marrett Road.

Figure 8 shows the results of the speed study. The average speed was 29 mph, and the 85th percentile speed 35 mph. The 85th percentile speed is a commonly used indicator of the travel speed along a roadway and signifies that 85% of vehicles travel below 35 mph and 15% travel above.

Traffic speeds along Marrett Road are slowed by the horizontal curve or "bend" at the intersection and by traffic turning to and from Spring Street.

Traffic Operations Analysis

Traffic operations are determined through an analysis of intersection level of service (LOS) calculations. LOS at intersections was calculated using Version 5 of the traffic analysis program Synchro. Synchro analysis is performed based on criteria established by the Transportation Research Board in its 2000 *Highway Capacity Manual* (HCM 2000). HCM 2000 determines the LOS and delay (in seconds) based on intersection geometry and available traffic data for each intersection.

LOS categories are similar to report card ratings for traffic performance. Intersections are typically the controlling bottlenecks of traffic flow, and the ability of a roadway system to carry traffic efficiently is generally diminished in their vicinities. LOS A, B, and C indicate conditions where traffic moves without significant delays over periods of peak travel demand. LOS D and E are progressively worse peak-hour operating conditions, and LOS F represents a situation where demand exceeds the capacity of the intersection.

Table 3, an excerpt from HCM 2000, provides LOS criteria for signalized and unsignalized intersections. LOS A defines the most favorable condition, with minimum traffic delay. LOS F represents the worst condition, with significant traffic delay and driver frustration.

Figure 8. Speed Study

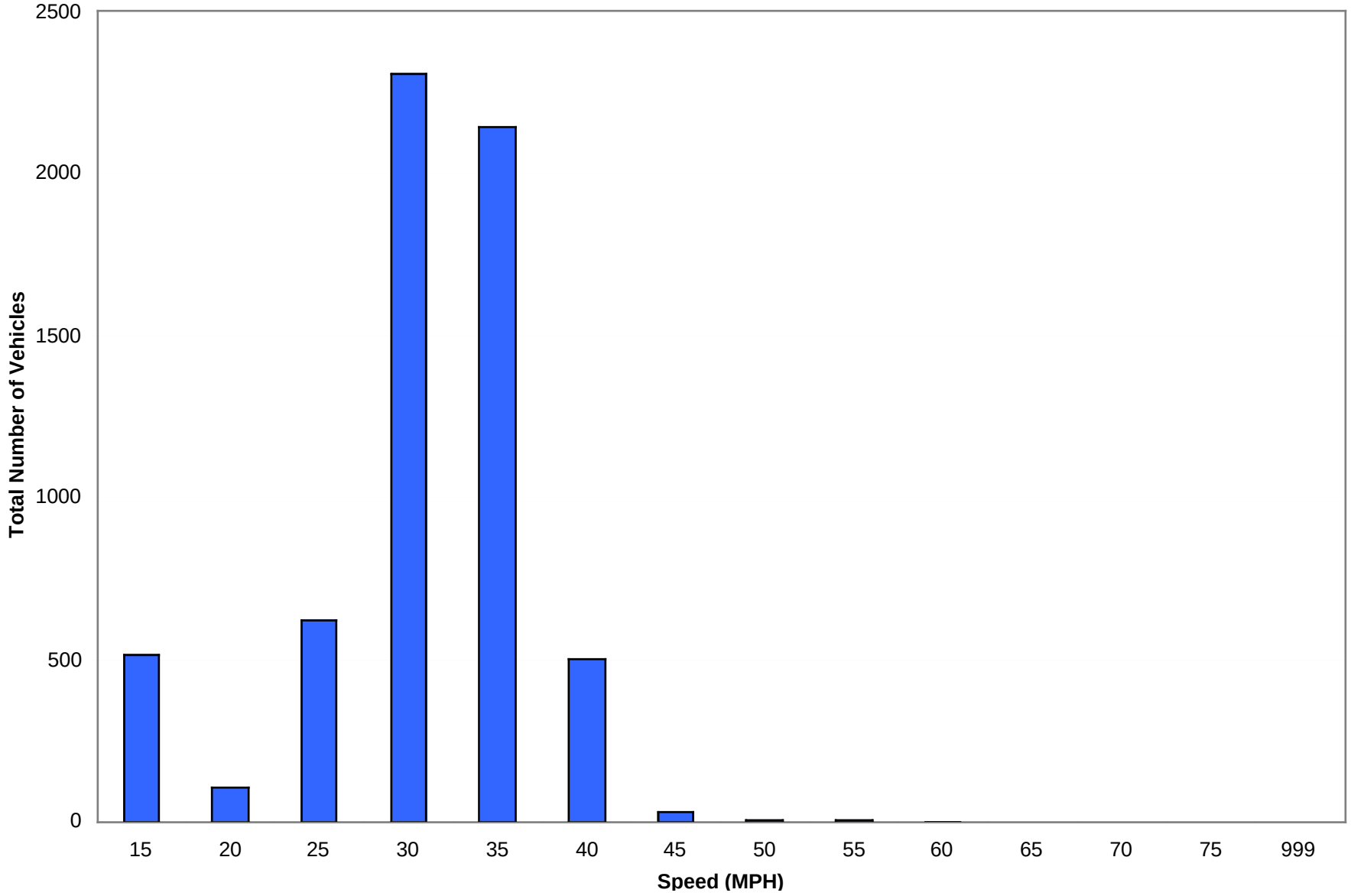


Table 3. Intersection Level of Service Criteria

Level of Service	Average Stopped Delay (sec./veh.)	
	Signalized Intersection	**Unsignalized Intersection**
A	<10	<10
B	>10 and <20	>10 and <15
C	>20 and <35	>15 and <25
D	>35 and <55	>25 and <35
E	>55 and <80	>35 and <50
F	>80	>50

HSH conducted a level of service analysis to evaluate existing intersection operations during the commuter and the Marrett Road/Spring Street/Bridge Street intersection peak hours.

Table 4 and **Table 5** summarize the morning and evening LOS analysis results for the study area intersections during the a.m. and p.m. peak hours. Complete Synchro reports are included in **Appendix A.**

Table 4. Existing Conditions (2005) LOS Summary, Marrett Road/ Spring Street/Bridge Street Intersection, a.m. Peak Hour

Movement	LOS	Delay	V/C Ratio	95th Percentile Queue
Unsignalized Intersection				
Marrett Road EB				
Marrett EB thru/right	A	0.0	0.58	0
Marrett WB left/thru	C	24.2	0.75	170
Spring NB left/right	F	>50.0	9.55	*

* Exceeds formula.

Table 5. Existing Conditions (2005) LOS Summary, Marrett Road/ Spring Street/Bridge Street Intersection, p.m. Peak Hour

Movement	LOS	Delay	V/C Ratio	95th Percentile Queue
Unsignalized Intersection				
Marrett Road EB				
Marrett EB thru/right	A	0.0	0.37	0
Marrett WB left/thru	A	4.5	0.15	14
Spring NB left/right	F	>50.0	2.26	1,305

* Exceeds formula.

The Existing Conditions operational analysis confirms observations at the intersection that Spring Street operates poorly and Marrett Road westbound experiences delay due to left-turning traffic.

During the peak commuting hours, the constant traffic flow on Marrett Road minimizes the opportunity for Spring Street traffic to access Marrett Road, as shown in the table above with Spring Street operating at LOS F.

Due to the narrow width and close proximity of the utility pole and hydrant to the curb line, left-turning Marrett Road westbound traffic frequently blocks through-traffic and causes additional delay for the Marrett Road traffic.

Development of Alternatives

Phase II evaluated the three distinct intersection control options that were advanced for further consideration following the initial outreach process. The control options were:

- Traffic signal;
- Modern roundabout; and
- Geometric improvements with stop control.

Although the three options focus on traffic control at the intersection, many other minor improvements may be implemented as a component of the overall option or as stand-alone improvements. This offers a fourth option, implementation of common features that include:

- Construction of new sidewalks along Spring Street;
- Installation of an actuated pedestrian traffic signal at the Bridge Elementary School and Reservoir;
- Relocation of westbound MBTA bus stop;
- Closure of Bridge Street except for emergency vehicle access; and
- Relocation of the utility pole and hydrant at the apex to the intersection.

HSH's initial screening of alternatives focused on combining elements that could be implemented as stand-alone improvements, such as the pedestrian improvements, with those elements that ranked high among participants at the public meeting in June 2005. It was clear from the key-person interviews and the comments and discussion at the public meeting that all the alternatives must respect the context and avoid or minimize land and property takings.

HSH developed conceptual plans for each option, based on aerial photography and existing roadway layout plans:

- traffic signal;
- modern roundabout; and
- geometric improvements with stop control.

Traffic Signal

The installation of a traffic signal would assign the right-of-way alternately between Marrett Road and Spring Street roadway approaches. Green time, in particular, would be assigned to Spring Street traffic, permitting the free flow of traffic through the intersection. Crosswalks and pushbutton pedestrian actuation would improve pedestrian safety. To enhance the aesthetics of the traffic signal system, a variety of design options is available through color of paint, signals placed on ground mounted poles versus mast arms, or decorative design of the poles.

Improved traffic flow through the intersection for Spring Street traffic will encourage traffic from the employment centers along Hayden Avenue to remain on Spring Street and to eschew the use of residential cut-through streets like Shade Street. The traffic signal option would not require permanent land takings.

The conceptual design of the traffic signal option is shown in **Figure 9.**

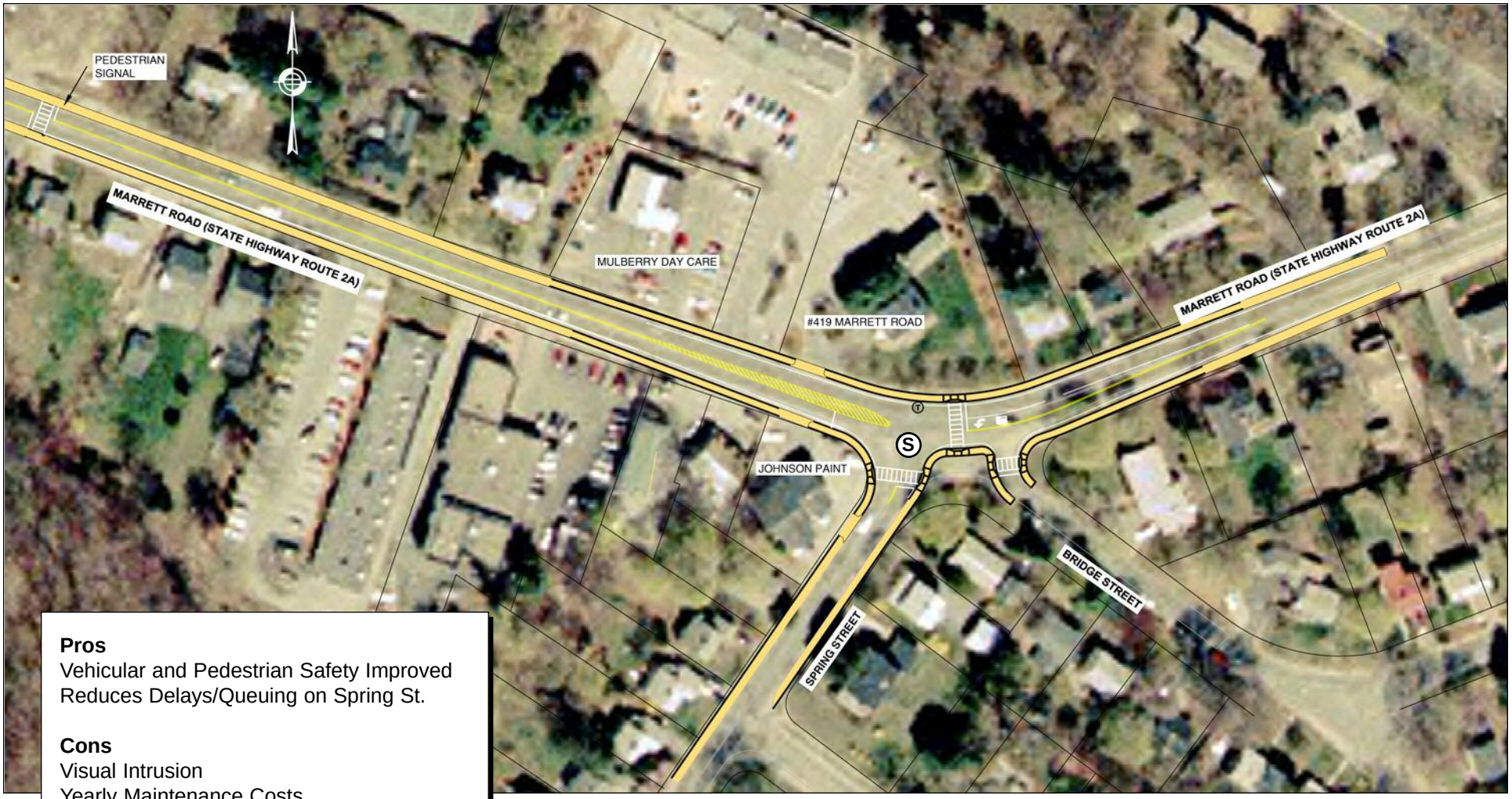
Advantages

- Would improve vehicular and pedestrian safety.
- Would reduce delays and queuing on Spring Street.
- Would encourage traffic to remain on Spring Street and shun residential cut-though.

Disadvantages

- The signal could be considered a visual intrusion.
- Operating a traffic signal involves yearly operating and maintenance costs.
- The presence of the signal that would reduce queues on Spring Street may encourage additional traffic.
- The signal will shift some delays and queuing to Marrett Road.

Figure 9. Conceptual Design–Traffic Signal Option



Pros
Vehicular and Pedestrian Safety Improved
Reduces Delays/Queuing on Spring St.

Cons
Visual Intrusion
Yearly Maintenance Costs
May Promote Cut-through Traffic
Shifts Some Delays/Queuing to Marrett Rd.

Modern Roundabout

As a traffic calming device, the modern roundabout would reduce operating speed along Marrett Road in particular. Delay and queuing would also be reduced, since all cars *approaching* the roundabout would yield to traffic already *in* the roundabout. Slower-moving traffic, combined with new pavement marking, would result in a safer travel environment for vehicular and pedestrian traffic. The land inside the roundabout could be landscaped or treated in a number of ways. Land taking on both the northerly side of the intersection and the southwest quadrant would be required for the roundabout, which is approximately 90 feet in diameter. See **Figure 10.**

Advantages

- Would improve vehicular and pedestrian safety.
- Would reduce traffic delays.
- Would include less pavement with landscaped media.

Disadvantages

- Significant land takings would be required.

Figure 10. Conceptual Design–Modern Roundabout Option

Pros
Vehicular and Pedestrian Safety Improved
Traffic Delays Reduced
Landscaped Median Possible

Cons
Significant Land Taking
MHD Skeptical on Use on Arterials

Geometric Improvements

This option retains the current stop control on the Spring Street approach and maintains the right of way along Marrett Road. The option relies on small actions to improve channelization through the intersection to help traffic and pedestrians to navigate more safely. Under this option, Marrett Road is widened to provide a left turn lane for traffic turning from Marrett Road to Spring Street. Currently, left turning traffic obstruct through traffic on Marrett Road through traffic. With slight roadway widening, pavement marking, and signage improvements, vehicular and pedestrian movements would be channelized more efficiently and more safely. No land taking would be necessary. **Figure 11** shows the conceptual plan for geometric improvements. The layout of the intersection for this option is very similar to the traffic signal design layout.

Advantages

- Would reduce driver confusion.
- Would reduce delays and queuing on Marrett Road westbound.
- Would introduce minor improvements in pedestrian safety.

Disadvantages

- Geometric improvements would do little to reduce delays on Spring Street.
- Widening Marrett Road will provide an uninterrupted through traffic stream Marrett Road that will reduce the number of gaps needed for Spring Street traffic during the evening peak period.

Common Features

All of the alternatives featured the following improvements:

- Sidewalks;
- Crosswalks;
- Marrett Road pedestrian signal;
- MBTA westbound bus stop relocation; and
- Hydrant relocation.

Figure 11. Conceptual Design–Geometric Improvements Option

Pros
Reduces Driver Confusion
Reduces Delays/Queuing on Marrett Rd. WB

Cons
Little Impact on Spring St. Delay
Minor Improvement in Pedestrian Safety

Evaluation

HSH reviewed the three intersection options with key stakeholders and with the Planning Department and Town Engineer on January 12, 2006. Since Marrett Road is under state jurisdiction, this meeting was followed with a meeting at Massachusetts Highway Department (MassHighway) District 4.

Massachusetts Highway Department

As Marrett Road (designated as Route 2A) is under state jurisdiction in the area of the intersection all modifications to the roadway must meet Massachusetts Highway Department (MassHighway) approval. In addition, since the intersection qualifies for state and federal funding for construction, the project team met with the MassHighway District #4 Project Development Engineer on January 30, 2006, at the District #4 Offices in Arlington to discuss the project development and outreach process.

MassHighway was pleased to be updated on the project and mentioned that all new design proposals must follow the procedures outlined in the new *2006 MassHighway Design Guidebook.* To initiate funding, the team must submit a Project Notification Form to the District office for review and approval.

MassHighway provided an update on the nearby Marrett Road/Waltham Street Signalized Intersection Improvement Project. Discussions are ongoing with regard to driveway access for the businesses located at the intersection. Since this intersection is in close proximity to the Marrett Road/Spring Street intersection, the progress and design will be monitored to ensure that the two intersections operate together efficiently.

Public Meeting, February 8, 2006

The Town held a follow-up public meeting for the Marrett Road/Spring Street/Bridge Street Intersection Study on Wednesday, February 8, 2006, at 7:30 p.m. in the Cary Auditorium at Cary Hall. This meeting was coordinated with a regular meeting of the Planning Board. Approximately 43 people attended, including members of the Planning Board, Board of Selectmen, and Department of Public Works, and interested residents and business owners. The purpose of this meeting was to present the three alternatives for the intersection and solicit input from meeting participants.

HSH reviewed the goals of the study and briefly recapped the work done to date, using PowerPoint to present summary information on the data collected, the traffic count program, and a description of the proposed intersection improvement alternatives:

- Traffic signal;
- Modern roundabout; and

- Geometric improvements.

A key feature of the presentation was a demonstration of how the intersection would operate and how traffic would flow in each option. Using simulation software, HSH graphically illustrated the impacts of a traffic signal, modern roundabout, and geometric improvements on traffic on Spring Street and Marrett Road.

HSH then led a discussion of the advantages and disadvantages of each option. In general, participants did not favor the modern roundabout because of the attendant land takings and concerns about pedestrian and bicyclist safety. Participants thought that both the traffic signal option and the geometric improvement options had merit, particularly because both options would improve channelization through the intersection and provide safer pedestrian crossings.

In addition to verbal comments and suggestions at the meeting, attendees were given mail-back comment forms for their own use or to relay to people who were unable to attend the meeting. Most of these forms were returned at the meeting, and five were faxed or e-mailed. To date, the study team has received 17 comment forms. The following is a summary of the comments received via the forms.

- Sidewalks are needed on Spring Street.
- Congestion at the intersection is worst during peak hours.
- Cost estimates for alternatives are needed.
- Gore lines and pavement markings paired with other improvements may improve current conditions at the intersection.
- Slowing cars on Marrett Road is critical for safety.
- A police officer should be stationed at the intersection during peak hours.
- Sidewalks, crosswalks, and pedestrian improvements are needed.
- Most traffic issues at this intersection could be addressed through improvements at other intersections, including:
  - Waltham Street and Marrett Road;
  - Route 2 and Spring Street; and
  - Route 2 and Route 128.

A complete record of the public meeting, including the postcard announcement, the agenda, the handout, the presentation, copies of individual comment forms, list of attendees, and *Lexington Minuteman* summary news article is included in **Appendix B.**

- "Walk to School Initiative" funding should be used to pay for crosswalks and other pedestrian improvements.

- Left turns at the intersections are dangerous, look at restricting left hand turns during peak hours.

Recommendations

Although the modern roundabout addresses the concerns regarding peak-hour traffic delays through balancing the delay for all traffic and travel speeds along Marrett Road, the need for significant land taking both north of the intersection and in the southwest quadrant appears to rule out the modern roundabout for further consideration.

The geometric improvement and traffic signal option are similar in design; neither requires additional land for implementation. The most significant difference is the provision of adequate gaps in the Marrett Road traffic flow to permit Spring Street traffic access to the roadway. Both options add an exclusive left-turn lane to Marrett Road westbound that clearly designates a left-turn pocket.

Today, the gaps are created in the westbound traffic flow as left-turning traffic blocks the through-movement. Spring Street drivers haltingly approach the intersection and make the turn when the gap is provided. With the introduction of the exclusive left-turn lane, through-traffic on Marrett Road will flow unhindered through the intersection, consequently reducing the number of gaps.

With the introduction of the exclusive left-turn lane, gaps in Marrett Road traffic need to be provided. Only the traffic signal can provide the gaps through assignment of right-of-way for traffic. The signal will provide safe and more efficient traffic flow during the peak periods. During the off-peak evening hours, traffic volumes are significantly lower, and the signal may be placed in a flashing mode that operates similarly to the existing stop control.

The improvement elements that were discussed as common features may be implemented as part of the overall intersection or individually. The common features all address singular issues, including improved pedestrian amenities, improved safety for school children, and improved safety for vehicular traffic.

Appendix A. Synchro Analysis

Appendix B. Public Meeting Record

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